Introduction of flexible monitoring equipment into the Greenlandic building sector

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Publication date:
2014

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Sisimiut, Greenland
7-9 April 2014

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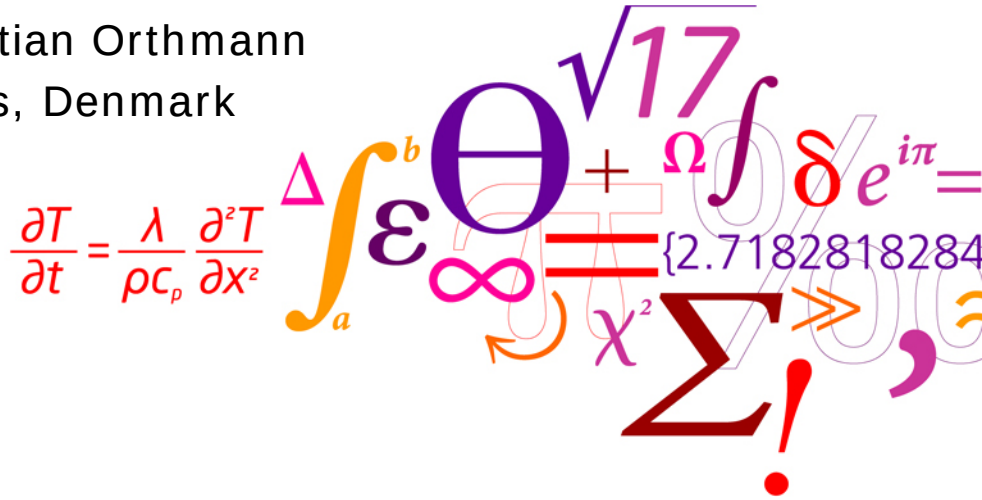

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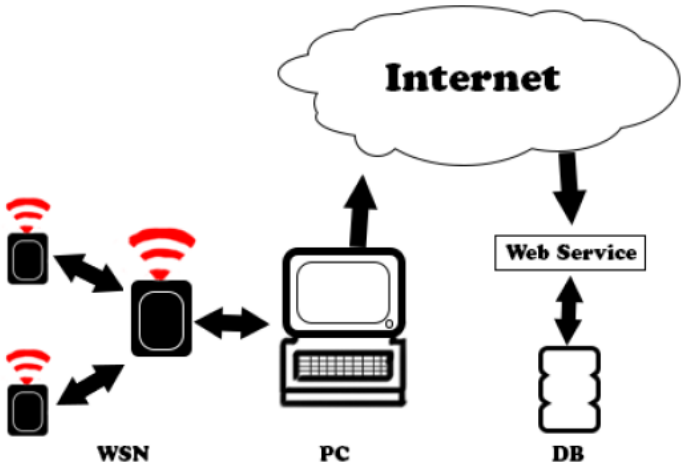
Wireless Sensor Network (WSN) - Basics



- Sensors of any type
- Connected thought network
- Communication wireless
  - with a Synchronization node
  - with each other
  - through each other (hops)

- Strength
  - Sensors can be added and removed in the running network
  - Sensors can communicate through each other

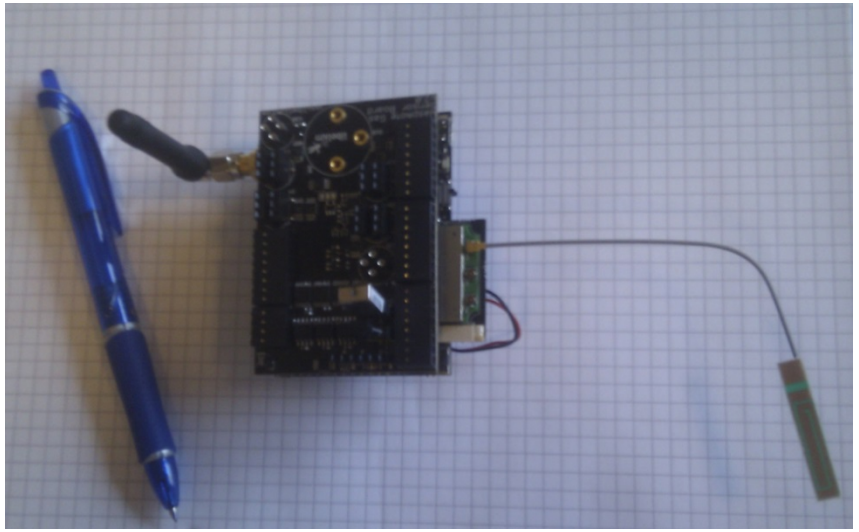
  - ... a very flexible selv configuring platform

Development History

- 1sd trial with SunSpots
  - Very good implementation of the WSN technology
  - Very bad implementation of the many sensors
    - E.g. Heat sensor was placed to near to the light diode
- 2nd trial with a development company
  - Lack of maturity
  - Lack of development infrastructure for programming the nodes
  - Very high price due to small production
- 3rd trial is the one presented here – Libelium Waspmote

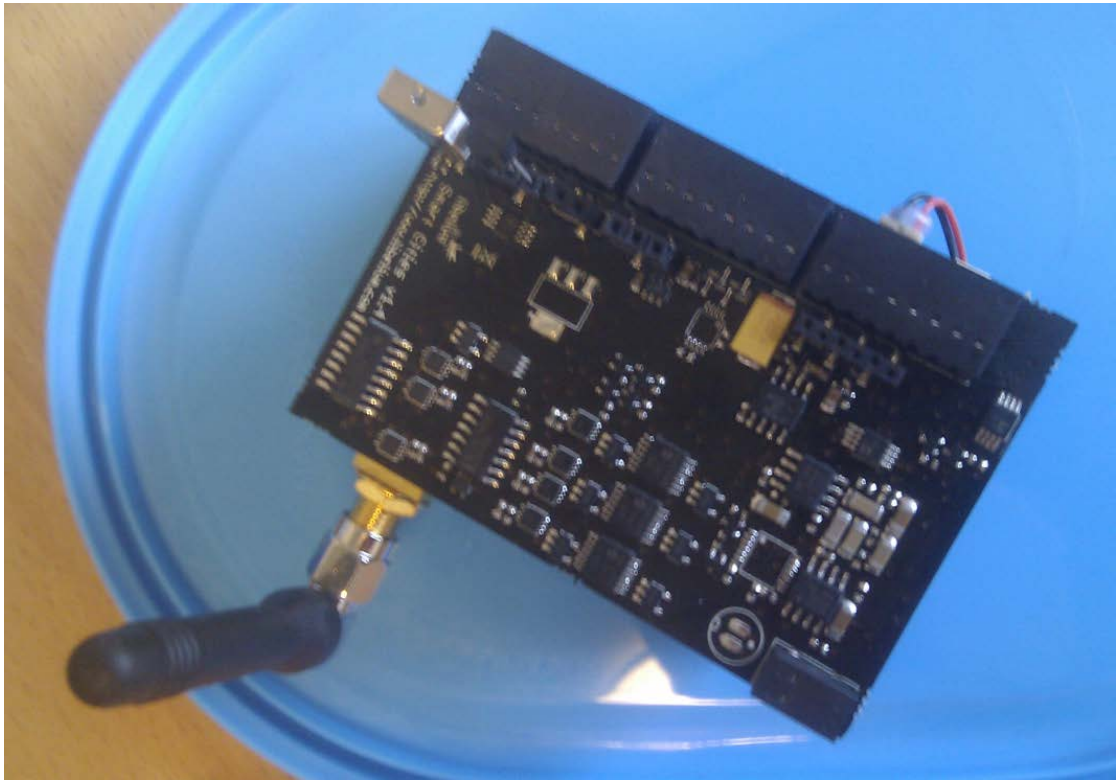
Waspmotes

- Extremely flexible development and demonstration platform
  - customizable
  - consisting of:
    - Sensor Board
    - Sensor Network modules (exchangeable)
    - Communication modules - plugins (GSM, Wifi, Zigbee etc.)
    - Battery packages
  - other characteristics
    - Open source
      - programming platform
      - policy
      - and community



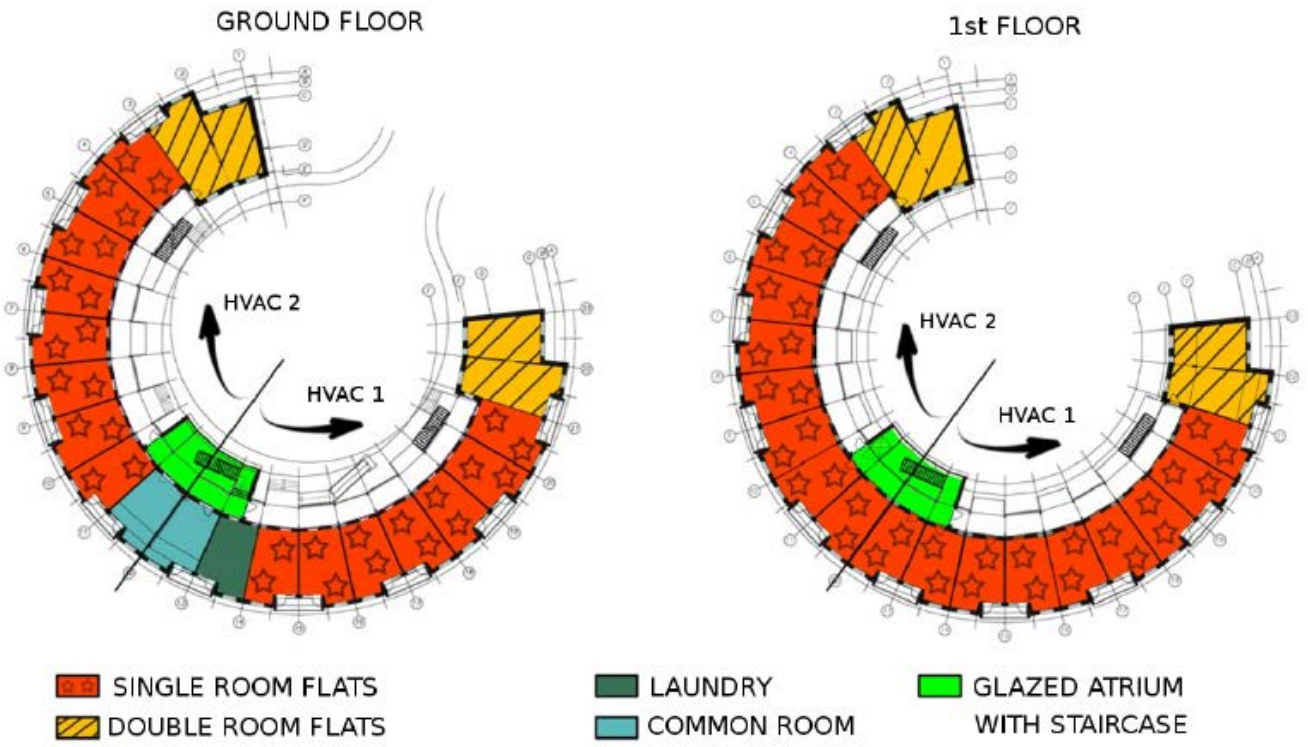
Laboratory testing

- Range in the free: 50 meters
- Range in buildings (steel-concrete and brick stones): 30 meters
- Battery charging and usage
- Sensor precision
- … and much more



The Building – Apisseq - Dormitory

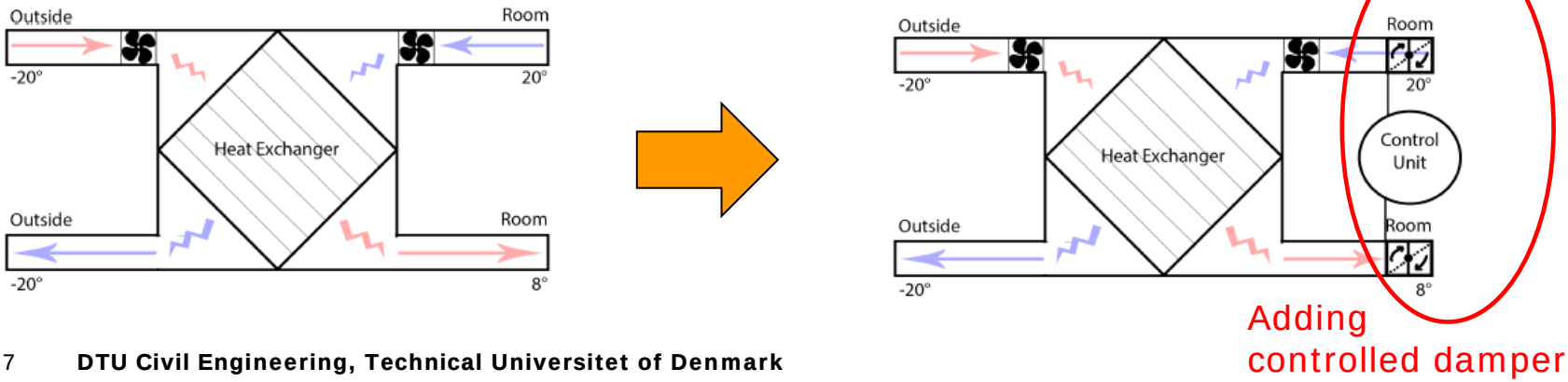
- Dormitory, built 2010



- Aim: To save energy and keep the indoor environment

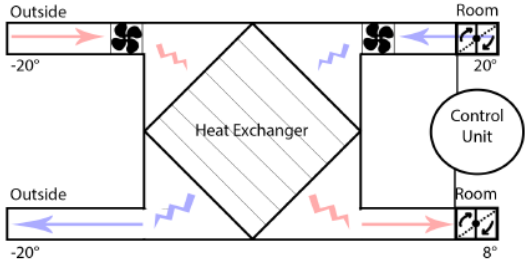
HVAC optimization

- Before:
  - On-off control which means on-all-the-time
- After:
  - Demand controlled on basis of CO2-measurements in every room
- Requires:
  - Sensors
  - Control strategy
    - If one sensor is above a threshold => ”On”
    - Else ”Off”
- Expected savings = >70% ventilation energy

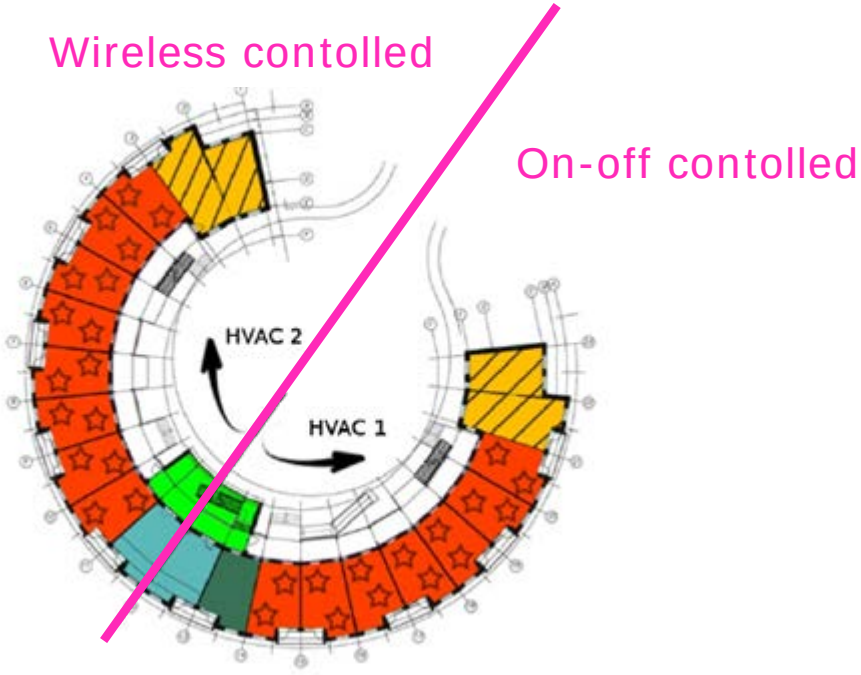


HVAC optimization

- Installation of 18 sensors
- .. on half of the symmetrical building



- Enables comparison of the two buildings
  - to be corrected for the influence of solar gain through windows



The Case Study Results – So fare …

- Update software on any device to same state
  - Not the case by delivery
- Test sensors (until experiences are large)
- Configuring is straight forward
- Open source platform, Arduino with some changes
- Casing must be solved
- With a few sensors on can do the work as one goes
- With many sensors on has to build up procedures
- Configuration and programming may take a few days (not fulltime at all)

- Unfortunately no results on monitoring due to delays

Costs

Table 2. Price estimation for the wired solution

Item	Price (incl.VAT)
18x CO_2 sensors (Vaisala CARBOCAP® GMW 22)	6,000 €,
Programmable logic controller with web server (Prolon PID 4000) including installation	4,000 €
Installation of the sensors	6,000 €
Total	**16,000 €**

Table 1 Price estimation for the wireless solution

Item	Price (incl.VAT)
19x Waspmote ZigBee PRO	3,800 €,
18x Gases Sensor Board v2.0	2,160 €
18x Solid electrolyte CO_2 Sensor TGS 4161	880 €
Meshlium ZigBee-PRO-AP	660 €
Installation of the sensors	500 €
Total	**8,000 €**

- plus configuration & programming for both solutions

- STATUS
  - Due to paternity leave, the project is derailed
  - Not installed yet (to be installed in April 2014)
  - To be reported in October 2014

Expected results above the case study

- Simple coupling to
  - ”Internet of Things”
  - ”Big data”
  - Building Automation / ”Smart Buildings”
  - ”Smart Grid”
- Applicable for Positioning

Further work and Opportunities

- Battery lifetime
- Battery charging
- … standardization on
    - Configuration
    - Programming
    - communication protocols
    - …
- Flexible monitoring system developments
  – Commissioning
  – Debugging

- Positioning – on basis of the node RSSI measurements (~ 40 cm precise)

Any Greenlandic reflection

- Assumptions:
  - Limited access to automation professionals in Greenland
  - Skilled labour is expensive
  - Demanding to come around
  - => Hence expensive to use professionals

Any Greenlandic reflection

- Drawback for WSN
  - Hardware can be cheep and expensive
    - (many possibilities – choose one)
  - Battery charching is not solved – el-wired is recommended
    - (not really wireless, well?)
  - Sensor quality depends on the sensors applied (price-performance)

Any Greenlandic reflection

- Strength of WSN
  - Extremely easy installation, after prepared configuration
  - Very cheap installation (if el-wired)
  - Remote configuration and programming
  - Remote and automated calibration of sensors (esp. CO2-sensors)
  - Repurposing of hardware (a topic in itself)

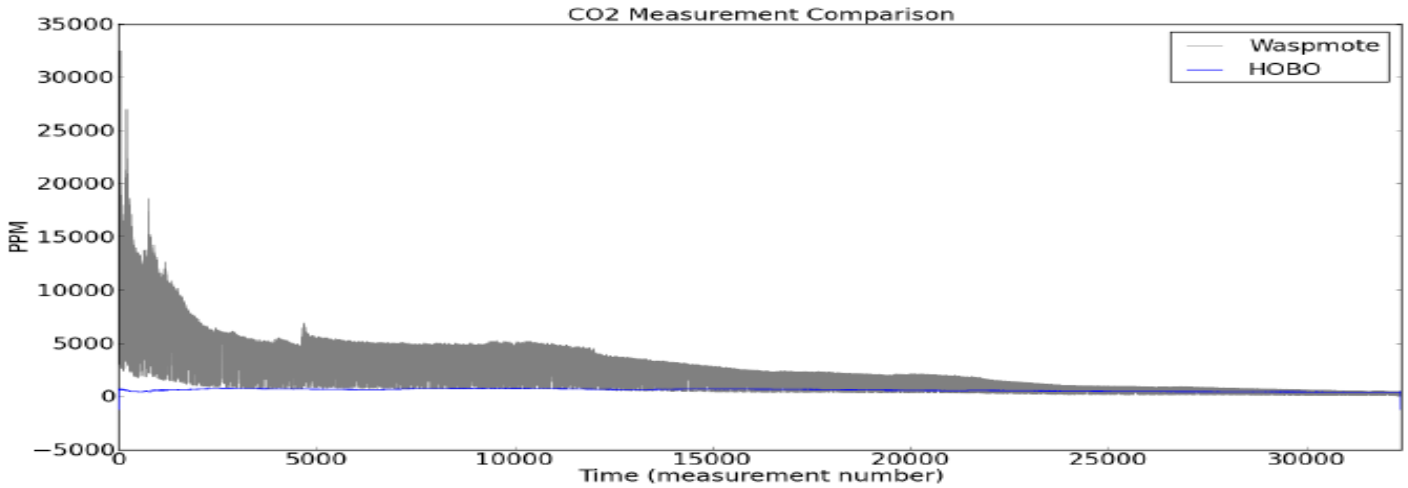
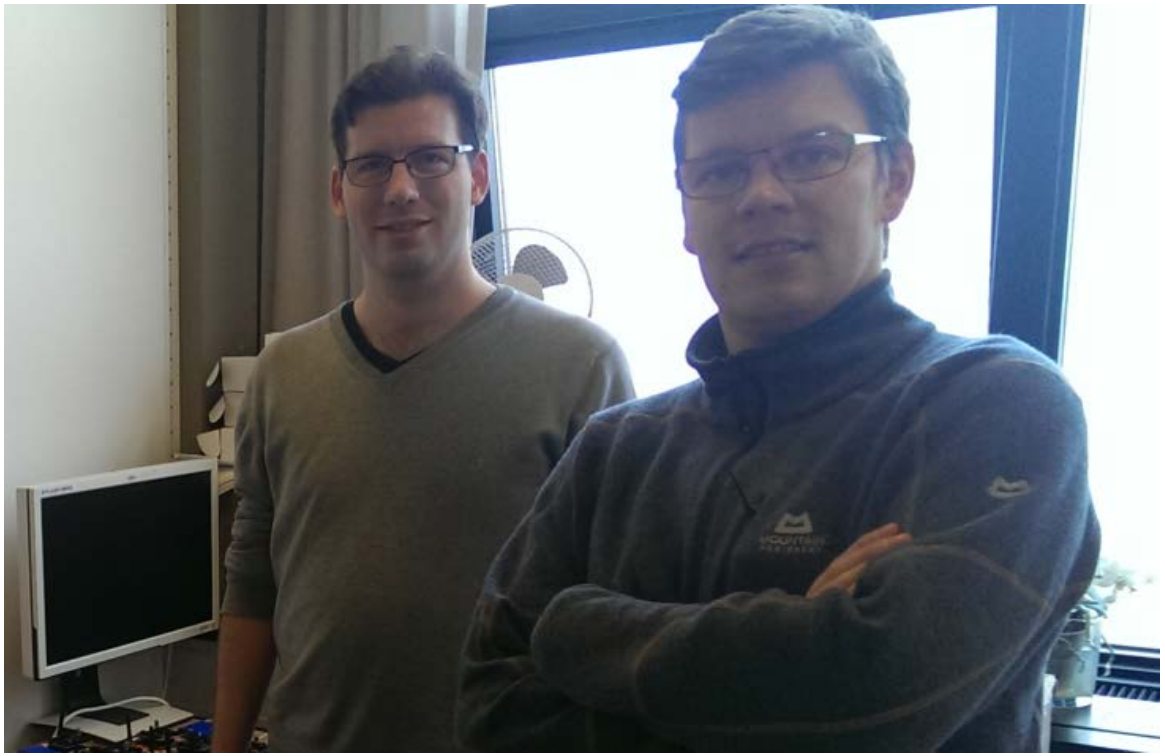


Figure 5.9: CO_2 measurements from the burning procedure

DThanks to …

- my colleagues
  - Christian Orthmann
  - Martin Kotol
- Bjarne Saxhof Foundation



Alternative platforms

- National Instruments
- Digital Instruments
- MakeThisWork
  - Danish produced
  - Communication: Bluetooth Low Energy – good battery conditions
  - rather expensive, 6000 DDK/node with a set of sensors)
- … and many more